Auditory and Vestibular Research

Profiling the impact of tinnitus in Indian population using ICF classification system: A cross-sectional study

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Abstract

Background and Aims: Tinnitus is a complex, multifactorial condition involving auditory and non-auditory systems. Individuals with bothersome tinnitus often report various associated problems, reflecting its diverse impact. This study aimed to evaluate the overall effect of tinnitus and correlate these findings with standard auditory measures using the International Classification of Functioning, Disability, and Health (ICF) framework.
Methods: The study included 117 individuals with tinnitus (Mean age = 39.7 years, SD = 12.58; 52.1% female). Participants completed the Tinnitus Handicap Inventory (THI). Hyperacusis and misophonia were assessed using the Khalfa Hyperacusis Questionnaire and the Amsterdam Misophonia Scale-Revised. Retrospective data on pure-tone audiometry and speech identification scores were collected. Two open-ended questions—the Problem Effects Question and the Life Effects Question—were used to explore the impact of tinnitus on daily functioning and quality of life.
Results: A total of 221 responses were collected for the Problem Effects Question and 140 for the Life Effects Question. Results showed that affected domains differed between the two questions: activity limitation was most prominent in the Problem Effects responses, while body function was most affected in the Life Effects responses.

Conclusion: No significant correlations were found between ICF-based responses and auditory measures like pure-tone audiometry or speech identification scores. However, strong correlations were observed between the Problem Effects, Life Effects, and THI scores, emphasizing the importance of self-reported measures in understanding the impact of tinnitus.
Keywords: Tinnitus, open-ended questions, activity limitation and participation restriction, life effects, problem effects.

INTRODUCTION

Tinnitus, derived from the Latin word *tinnire* meaning "to ring," refers to the conscious perception of sound in the ear without external stimulation [1]. The sensation of tinnitus can either be subjective, which means it is only perceived by the person experiencing it, or less frequently objective, where an outside observer can also hear the sound [2]. This condition is commonly accompanied by physiological and psychological difficulties such as anxiety, depression, and insomnia [3].

Tinnitus is closely related to hearing loss in most cases but can also occur without hearing loss [4]. Several otological conditions can cause tinnitus, including ototoxicity, noise-induced hearing loss (NIHL), Meniere's disease, and presbycusis. Tinnitus can also develop due to emotional factors and stress [5]. The generation of tinnitus can often involve multiple factors, meaning that a combination of changes in the way sound and physical sensations are perceived, along with abnormal activity in certain parts of the brain due to factors such as physical damage, lack of blood flow, or emotional factors, may contribute to the development of tinnitus. Additionally, the factors that contribute to the development of tinnitus may not be the same as those that are responsible for its long-term existence, as evidenced by the fact that while many individuals experience temporary tinnitus following exposure to loud noises, only a small percentage of them develop persistent tinnitus [6].

The impact of tinnitus on quality of life varies greatly from person to person, and tinnitus may be more likely to be experienced by a person as a "distressing" condition depending on their personality traits [7]. It can also lead to sleep disturbances, cognitive challenges, and emotional distress [8]. About half of the people with tinnitus complain of sleep disturbances [9]. Chronic sleep deprivation caused by tinnitus may lead to difficulty concentrating, feelings of frustration and anger. Tinnitus can further impair one's ability to interact normally with others, leading to chronic stress, which can possess such adverse effects as the inability to eat, drive, or do any kind of chores.

It is evident that the overall quality of life of an individual with tinnitus is affected [10]. Tinnitus has been quantified using a variety of scales and inventories, but most of them focus primarily on its emotional and psychological effects. It has been recognized for years that tinnitus has adverse effects that must be measured uniformly and reliably. This objective justifies the creation of a universally valid questionnaire to evaluate various tinnitus drawbacks. The The International Classification of Functioning, Disabilities, and Health (ICF) framework offers a culture-neutral language for analysing the consequences of health conditions and is straightforward to compare across populations.

ICF is a comprehensive framework developed by the World Health Organization to aid in conceptualizing the effects of health problems and disability (figure 1). It describes the overall impact of any condition on an individual's general and emotional health status. The ICF framework is divided into the following components: body structures (*s*), body functions (*b*), activities and participation (*d*), environmental factors (*e*), and personal factors (*pf*) [11]. The utility of this framework in addressing the overall impact of auditory disorders such as hearing impairment [12] including single-sided deafness [13] , tinnitus [14], meniere's disease [15] , as well as vestibular disorders such as benign paroxysmal positional vertigo and vestibular migraine[16] has been documented in the literature. Only two studies have previously used the ICF framework to analyse the effects of tinnitus [14, 17].

Given the scanty literature dealing with the overall perceptual profiling of tinnitus in everyday situations and the ever-increasing need to understand the same, the current study aims to utilize ICF to shed light on individuals' hardships tinnitus experience daily, which are otherwise ignored mainly in auditory tests. This study investigates the challenges and impacts on the quality of life faced by individuals with tinnitus in the Indian population.

This present study attempted to evaluate the use of ICF framework in determining the problems experienced by individuals with Tinnitus. It will also be attempted to correlate these findings with various audiological features

of individuals with tinnitus. The present study attempted to characterize the primary challenges and impacts on the quality of life encountered by individuals with tinnitus. The study's objectives were: 1) To use ICF categorization to determine the consequences and life effects of tinnitus, focusing on the areas of body function, body structures, activities, involvement, contextual variables, environmental factors, and personal factors. 2) To identify which domain- body structure (s), body function, activity restriction and participation restriction, environmental variables, and personal factors have the most challenges and consequences on people with tinnitus. 3) To correlate the pure tone average, speech identification, and tinnitus handicap inventory (THI) scores with ICF categories.

MATERIALS AND METHODS

Informed consent and ethical consideration

The participants were provided with informed consent, which included an explanation of the purpose of the study and its importance in a concise manner. The study ensured that the participants remained anonymous throughout the research. The patient's willingness to participate in the study did not influence the standard audiological assessment or any other evaluations conducted on them. The study followed the ethical standards for bio-behavioral research established by the institutional review board.

Research design

A cross-sectional survey design was used as the data collection method for the study. The data was collected through a qualitative interview process followed by comparing their audiological test results. Individuals with tinnitus who reported to the institute and underwent Audiological testing at the Department of Audiology were involved in the study.

Participants

The study involved 117 individuals diagnosed with tinnitus aged 18-70 with an average age of 39.7 (SD=12.58). Among those participants, 56 were male and 61 were female. The participants meeting the following inclusion and exclusion criteria were considered for the study: 1) Individuals reporting tinnitus between the age range of 18-70 years. 2) Individuals with subjective, unilateral, or bilateral continuous tinnitus were considered for at least three months. 3) The hearing loss of the individuals ranged from Normal hearing sensitivity to Profound hearing loss (100 dB HL). 4) Individuals suffering from other co-morbidities, such as hyperacusis and misophonia, were excluded.

Procedure

The study was carried out in three stages.

Phase I: The information was gathered via an online/offline survey about (a) demographical characteristics (such as age, gender, and work status), (b) tinnitus-related variables (such as duration of tinnitus, type of tinnitus, the onset of tinnitus), (c) standardized questionnaires (THI) [18]. The section included questions to identify whether the individual has Hyperacusis and Misophonia. The Khalfa Hyperacusis Questionnaire [19] and the Amsterdam Misophonia Scale Revised (AMISOS-R) [20, 21] were used as a tool to identify individuals who exhibit the symptoms of Hyperacusis and Misophonia, respectively. The THI is composed of 25 individual questions, each of which offers three possible responses: "yes" (score-4), "sometimes" (score-2), and "no" (score-0). The total score can range from 0 to 100. The greater the score, the more severe the impact of tinnitus on a person's functioning.

The two open-ended questions administered were a Problem question (PQ) and a Life effects Question (LEQ), based on the previous studies on tinnitus and hearing loss [22, 23]. The two open-ended questions focus on difficulties associated with tinnitus and its effects on everyday life. The questions were: 1) PQ: 'Make a list of challenges you have due to your tinnitus. Write down as many as you can think of. 2) LEQ: Make a list of the effects of tinnitus on your life. Write down as many as you can think of.

These questions were translated into Kannada by three native Kannada speakers. A translation agreed upon by two-thirds of native speakers was considered for use in the study. A reverse translation of these questions was performed to find out if there were any translation errors. The finalized questions were loaded onto the Google form or asked verbally or in a written form. Only participants who were willing to answer the questions participated in the study. The questions were asked through direct interviews and gave the responses for each question. These responses were recorded and given to native Kannada speakers for translation.

The participants were requested to respond in their favored mode, in writing, voice recording, or typed text. Participants were contacted through mobile phones and informed about the study; only those who desired to participate were included. They were given two options: answer these questions via a link to the Google form or use a mobile phone to answer them. Later, using native Kannada speakers, the mobile conversations were documented and transcribed verbatim. Whenever the participants could not understand the conversation over the phone, the caregiver was contacted for assistance.

Phase II: ICF coding*:* The responses were classified into domains utilizing the ICF, representing a comprehensive context for understanding disability, health, and functioning. ICF divides information into two main categories: (i) functioning and disability and (ii) contextual factors. The two main parts are segmented into smaller components: body function, body structures, activities and participation, environmental factors, and personal factors [24]. The body function encompasses the physiological operation of bodily systems, such as the ability to perceive sound.

The 'seven-step linking procedure' was used as an analytical method to connect all the data to the ICF framework [25]. The seven steps are (1) meaningful unit identification, (2) defining the significant concept(s), (3) underlying meaning interpretation, (4) determining the linking unit(s), (5) appropriate ICF category derivation, (6) documenting the linking rule applied, and (7) verifying the representativeness of the ICF categories chosen. The initial analysis stage involves identifying words that carry significant meaning and can be considered essential elements. These words were counted and studied to identify significant patterns and ideas. The concept is interpreted to obtain its underlying meaning. Linking units are determined based on the underlying meaning. Units of this kind are used across various responses based on similar concepts and patterns. The unit is categorized based on the domains outlined in the ICF framework through a process of coding.

The ICF classified the codes into different categories, including body functions, activity limitations, participation restrictions, and environmental and personal factors. The transcribed responses were provided to three coders to improve the coding process' reliability. Responses were counted for PQ and LEQ, as well as for total responses (PQ + LEQ). If there was any discrepancy in the coding, it was discussed among the coders, and a final consensus was obtained. Reliability analysis for these three coders' coded responses was done using IBM Statistical Package Social Sciences (SPSS) version 25.0 (IBM Corp. Released 2017).

Phase III: A retrospective collection of auditory effects from clinical records.

The audiological information was analyzed retrospectively by examining the relevant case files. Clients enrolled and reported with tinnitus (as mentioned in the case files) were considered. The test results in pure tone audiometry, speech audiometry (speech identification scores), and Tinnitus Handicap Index scores were noted and entered in Google Sheets. Hearing sensitivity was assessed behaviorally using pure-tone audiometry. The speech identification score was determined by presenting a list of unknown single-syllable words at +40 dB HL above the speech recognition threshold. SIS is determined by the number of correct words out of the number of presented words.

Quantitative Data Analyses

The statistical analysis was performed using IBM Statistical package for social sciences (SPSS) version 20.0 and Graph Pad Prism 9. Descriptive statistics were analyzed, including calculating means and standard deviations. An inter-rater reliability check was done using Bland-Altman agreement analysis. The normality check was done using Shapiro-Wilk's test. After determining the result of the normality test, the Wilcoxon signed-rank test was performed to assess whether there was a statistically significant difference in the number of responses. The effect size was calculated using the formula $r = (Z/\sqrt{N})$ whenever the results were statistically significant [26]. Spearman's rho correlation coefficient was tested to establish the relationship between the questions mentioned in PQ and LEQ with the audiological variables. Statistical significance was set at a two-tailed level of $p < 0.05$ for all analyses.

RESULTS

This study aimed to analyse and describe the issues and impact on the quality of life individuals with Tinnitus suffer. One hundred seventeen individuals were asked two open-ended questions, and their responses were collected. The participants' responses were transcribed verbatim, and three coders gave ICF codes to the responses

respective to the keywords. All the participants' audiological data was collected from their case files. Inferential and descriptive statistics were computed using SPSS (version 20.0). The Shapiro-Wilk's test was performed to check the normality of the data, and the data were found to be non-normally distributed (p<0.05). Therefore, non-parametric inferential statistics were used for additional analysis. The following sections explain the study's findings:

Impact of tinnitus across different domains of ICF

The problem effects of Tinnitus patients were reported more frequently than life effects. Within the Problem effects, the Activity limitation and Participation domain have the highest frequency of responses. A total of 361 responses were obtained within the domain of Activity Limitation and Participation. Of the 361 responses within the Activity limitations and Participation restrictions domain, 221 were obtained from the PQ, while the remaining 140 came from the LEQ. The most commonly occurring group was "Recreation and leisure" (d920), with a frequency count of 70 responses. The category that had the second highest frequency count was "Sleep function." Similarly, the Body function domain has the second-highest number of responses, with a total count of 241 responses. Additional categories which appeared more frequently include "Attention function" (b240), "Thinking" (d163), "Focusing attention" (d160), "Aural pressure" (b2405), "Reading" (d166), "Carrying out daily routine" (d230), "Watching" (d110). The details of the affected category are illustrated in Figure 2.

A total of 19 responses was obtained from Environmental factors, with the highest number being from the "Sound Intensity" (e2500) category. In addition to these domains, there were unclassifiable or non-codable factors. The frequency response of domains such as Body function, Activity limitation and Participation Restriction, and Environmental Factors with their respective codes are given in Table 1 to Table 3.

Most of the difficulties mentioned were related to activity limitations and participation restrictions. There were 221 responses to PQ and 140 responses to LEQ.

Quantification of problem and life effects of individuals with tinnitus

Five hundred ninety-one responses (PQ: 433 and LEQ: 158) were obtained from 117 adults with Tinnitus using two open-ended questions. The total number of responses ranged from 1 to 14 for PQ, and most participants gave 1 to 5 relevant answers, with 14 being the highest number of responses . Whereas, the meaningful responses ranged from 1 to 2 for LEQ, with 5 being the highest as illustrated in Figure 1.

For PQ and LEQ, each participant's average responses were 3.70 (±2.66) and 1.35 (±1.15), respectively. There was a significant difference in the total number of responses between PQ and LEQ (/z/= 8.35, p < 0.05, re= 0.77).

Correlation between PQ, LEQ responses, audiological variables (PTA, SIS), and THI Scores:

The Spearman's rho correlation was carried out to examine the relationship between PQ, LEQ, audiological variables (PTA, SIS), and THI scores. The results showed a strong correlation between the number of PQ (r_s= 0.76, p<0.01) and LEQ (r_s= 0.75, p<0.01 responses with THI scores and a weak correlation among audiological variables. No statistically significant correlation ($p>0.05$) *was* found between the PQ and LEQ responses and Audiological variables like PTA and SIS.

In summary, the study findings revealed that the Activity Limitation Participation Restriction domain showed the highest response rates. Significant differences were observed between responses to the PQ and LEQ. While no associations were identified between PQ and LEQ responses and audiological parameters such as PTA and SIS, a strong correlation was noted between the number of responses to PQ and LEQ and the THI scores.

DISCUSSION

This study assessed the challenges and life effects experienced by 117 individuals with tinnitus, employing open-ended questioning and categorizing the responses using the ICF. The results provide crucial insights into the multifaceted impacts of tinnitus, which range from activity limitations and participation restrictions to impairments in body functions and interactions with environmental factors. These findings affirm the need for holistic approaches in both assessment and management.

The results revealed that tinnitus significantly impacts activity limitations and participation restrictions, particularly in areas such as "Recreation and Leisure" (d920), "Focusing Attention" (d160), and "Carrying Out Daily Routine" (d230). Over half of the responses were associated with this domain, consistent with previous research highlighting tinnitus's interference in everyday activities [27]. This suggests that tinnitus often disrupts individuals' ability to engage in meaningful tasks and maintain their quality of life. Similarly, body functions such

as sleep (b134) and attention (b140) were heavily impacted, echoing studies that connect tinnitus with cognitive difficulties and sleep disturbances [28, 29].

Notably, a significant difference was observed between the number of responses to the PQ and LEQ, with the PQ eliciting a higher volume of responses. This finding aligns with earlier studies, such as Manchaiah et al. [14] which also reported greater participant engagement with questions focused on problems rather than broader life effects. This discrepancy could be attributed to the immediate and tangible nature of problems caused by tinnitus, which participants may find easier to articulate compared to more abstract life effects.

The study also identified a strong correlation between the number of responses to the open-ended questions and the THI scores, validating the use of these tools in tandem. However, weak correlations were found between the audiological measures (pure tone averages and speech identification scores) and the responses to open-ended questions. This suggests that the severity of tinnitus's life effects is not solely determined by hearing loss but is also shaped by psychosocial factors, consistent with the biopsychosocial model of health [30].

Open-ended questioning proved instrumental in capturing the diverse experiences of individuals with tinnitus. Unlike structured tools, this method allowed participants to express their unique challenges in their own words, providing richer and more nuanced data. Responses included difficulties in social situations, shopping, and driving—areas not typically covered by standardized questionnaires but critical to understanding the full scope of tinnitus's impact. This approach complements quantitative tools, offering a broader perspective on the condition's multidimensional effects. Recent research emphasizes the importance of such methods. For instance, Bhatt et al. [29] advocate for patient-centered assessment techniques that prioritize individual experiences. By integrating open-ended questions into tinnitus evaluations, clinicians can uncover underlying issues that might otherwise go unnoticed, leading to more targeted and effective interventions.

Implications for Practice and Research

The findings highlight the necessity of a biopsychosocial approach in tinnitus assessment and management. Clinicians should consider integrating open-ended questions into routine evaluations to capture a comprehensive view of patients' challenges. These tools can also guide the development of personalized rehabilitation plans, addressing both audiological and psychosocial needs. For example, individuals reporting significant difficulties in "Focusing Attention" (d160) may benefit from cognitive-behavioral therapy, which has been shown to alleviate tinnitus-related distress [31].

Furthermore, this study underscores the potential for ICF-based frameworks to enhance understanding and communication in tinnitus research. By categorizing responses into standardized domains, the ICF enables comparisons across studies and populations, facilitating the identification of common patterns and unique challenges. This approach could also inform the design of clinical trials, ensuring that interventions target the most relevant domains of impairment.

Strengths and Limitations

A major strength of this study is its use of open-ended questions and ICF coding, which provided a detailed and comprehensive view of tinnitus's impacts. Additionally, the inclusion of multiple response formats (e.g., written, verbal) likely contributed to the richness of the data. However, the small sample size limits the generalizability of the findings, and future studies should aim to include larger, more diverse populations. Incorporating additional audiological measures, such as pitch and intensity matching, could also enhance the understanding of tinnitus's effects.

Future Directions

To build on this study, future research should explore the longitudinal impacts of tinnitus, examining how the condition evolves over time and how interventions influence its effects. Additionally, incorporating modern technologies, such as mobile apps or wearable devices, could facilitate real-time data collection and provide deeper insights into the daily experiences of individuals with tinnitus. Recent advancements in machine learning could also be applied to analyze open-ended responses, identifying patterns and themes with greater efficiency.

Conclusions

This study underscores the significant and multifaceted impacts of tinnitus, particularly in activity limitation and participation restriction domains. The findings highlight the value of combining open-ended questioning with standardized tools, providing a richer understanding of the condition's effects. By adopting a biopsychosocial

approach and leveraging frameworks like the ICF, clinicians and researchers can develop more effective strategies for assessing and managing tinnitus, ultimately improving the quality of life for those affected.

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Table 1: Frequency counts of all the responses under the domain of activity limitation and participation restrictions

Function	Codes	PQ (n=221)	LEQ (n=140)	Total (n=361)
Carrying out daily routine	d230	22	1	23
Reading	d166	24	0	24
Doing housework	d640	11	0	11
Driving	d475	18	0	18
Listening	d115	11	0	11
Focusing attention	d160	29	0	29
Writing	d170	1	0	1
Using telecommunication devices	d3600	5	0	5
Handling stress and other psychological demands	d240	5	0	5
Shopping	d6200	3	17	20
Thinking	d163	33	0	33
Recreation and leisure	d920	1	69	70
Communicating with—receiving—spoken messages	d310	1	1	2
Acquiring, keeping and terminating a job	d845	3	8	11
Speaking	d330	10	8	18
Watching	d110	23	0	23
Conversation	d350	9	1	10
Walking	d450	1	0	1
Undertaking multiple tasks	d220	1	0	1
Conversing with many people	d3504	3	1	4
Moving around outside the home and other buildings	d4602	1	0	1
Making decisions	d177	4	0	4
Using transportation	d470	1	0	1
Carrying out multiple tasks	d2200	1	0	1
Sports	d9201	0	2	2
Informal relationships with friends	d7500	0	4	4
Socializing	d9205	0	7	7
Family relationships	d760	0	3	3
Community life	d910	0	9	9
Informal social relationships	d750	0	2	2
Ceremonies	d9102	0	3	3
Arts and culture	d9202	0	1	1
Full-time employment	d8502	0	3	3

Table 2: Frequency counts of all the responses under the domain of impairments ofbody functions

Definition	Codes	PQ (n=236)	LEQ (n=5)	Total (n=241)
Attention function	b240	34	0	34
Sensations associated with hearing and vestibular function	b140	1	0	1
Emotional functions	b152	21	0	21
Pain in head and neck	b28010	18	0	18
Range of emotion	b1522	1	0	1
Sleep function	b134	47	0	47
Amount of sleep	b1340	5	0	5
Aural pressure	b2405	28	0	28
Vestibular function of balance	b2351	10	0	10
Memory functions	b144	2	0	2
Energy and drive functions	b1300	12	0	12
Hearing functions	b230	14	0	14
Nausea associated with dizziness or vertigo	b2403	3	0	3
Dizziness	b2401	7	0	7
Auditory perception	b1560	1	0	1
Speech discrimination	b2304	2	0	2
Sustaining attention	b1400	4	4	8
Sensation of falling	b2402	1	0	1
Irritation in the ear	b2404	2	0	2
Confidence	b1266	2	0	2
Sensation of pain	b280	19	0	19
Regurgitation and vomiting	b5106	2	0	2
Extraversion	b1260	0	1	1

Table 3. Frequency counts of all the responses under the domain of environmentalfactors

Definition	Codes	PQ n=0	LEQ n=19	Total n=19
Sound	e250	0	2	2
Sound Intensity	e2500	0	10	10
Products and technology for communication	e125	0	1	1
General products and technology for communication	e1250	0	1	1
General products and technology for personal use in daily living	e1150	0	2	2
Individual attitudes of friends	e240	0	1	1
Products and technology for culture, recreation and sport	e140	0	2	2

Table 4: Correlation among the number of responses to the problem and life effects question, audiological variables and tinnitus handicap index scores

		THI scores	PTA of Right ear	PTA of Left ear	SIS of Right ear	SIS of Left ear
PQ	Spearman's rho correlation	0.760	0.177	0.097	0.196	0.023
	Significance	0.00	0.057	0.296	0.034	0.806
LEQ	Spearman's rho correlation	0.747	0.160	0.200	0.165	0.085
	Significance	0.00	0.085	0.031	0.075	0.362

Note. PQ-problem question, LEQ-Life effect question, PTA= Pure Tone Average, SIS= Speech Identification score, THI= Tinnitus Handicap Inventory

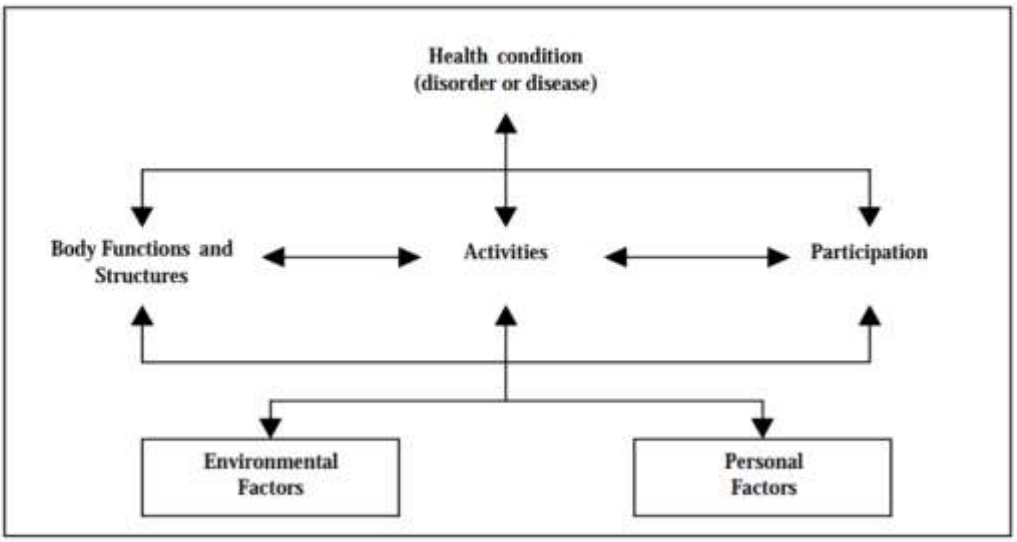

Figure 1: Various components of International Classification of Functioning, Disability, and Health from World Health Organization

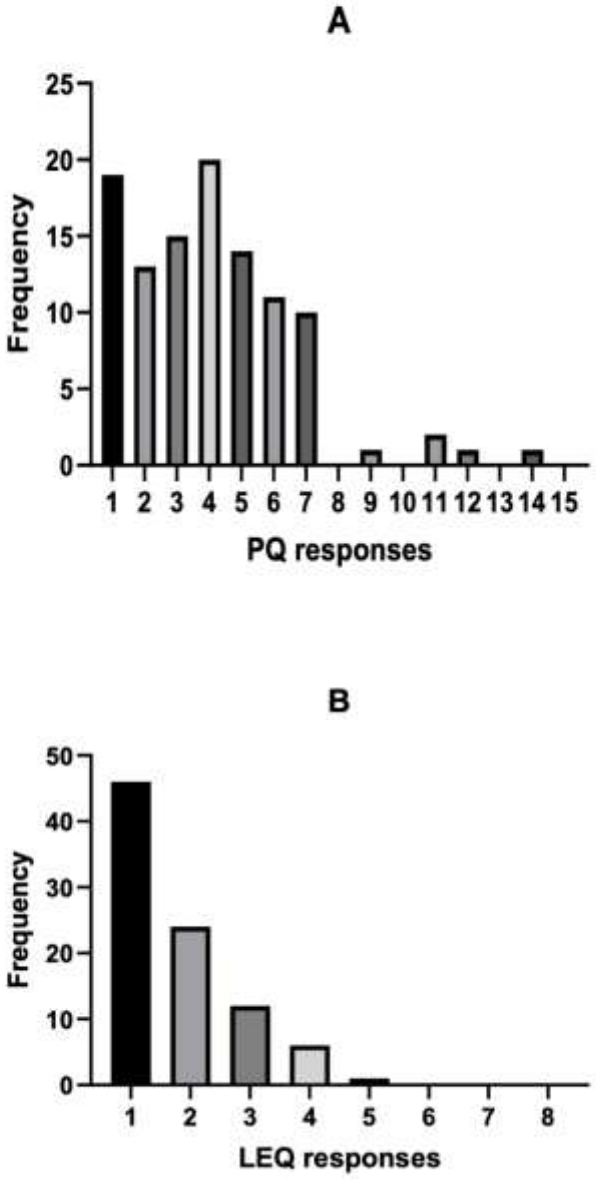

Figure 2 (A): The number of meaningful responses reported by the participants in problem question (PQ) (x axis represent the number of response code and y axis represent frequency for each count of response code)
(B): The number of meaningful responses reported by the participants in life effect questions (LEQ) (x axis represent the number of response code and y axis represent frequency for each count of response code).